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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/666,359

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Chi-Chun Chen

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EXAMINER

SMITH, FRANCIS P

ART UNIT

PAPER NUMBER

1792

MAIL DATE

DELIVERY MODE

06/24/2008

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/666,359	Applicant(s) CHEN ET AL.	
	Examiner Francis P. Smith	Art Unit 1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 19 September 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-43 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-43 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Terminal Disclaimer

1. The terminal disclaimer filed on May 6, 2008 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of US 6,642,117 B1 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Response to Arguments

2. Applicant's amendment to clarify [0010] of the specification, filed on May 5, 2008, is acknowledged.

Applicant's arguments have been fully considered but they are not persuasive. In response to applicants' argument regarding the plasma nitridation/re-oxidation of claims 1, 16-19, 23, and 38-41, Raaijmakers discloses subsequent dielectric deposition is aided by plasma energy whereby nitrogen radicals are introduced by flowing N₂ through the plasma generator. Furthermore, following the nitride deposition (i.e. completing the intermediate stacked gate dielectric), an anneal step is performed by introducing nitrogen and oxygen radicals (ionized by the plasma generator) to the anneal environment (i.e. plasma re-oxidation) (col. 21, lines 1-5; col. 22, lines 3-25). Therefore, Raaijmakers' anneal step containing plasma generated nitrogen and oxygen radicals serves as plasma nitridation and re-oxidation steps, respectively.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1, 2, 4-15, 20-24, 26-37, 42, and 43 stand rejected under 35 U.S.C. 102(b) as being anticipated by Raaijmakers et al. (US 6,348,420).

For claims 1 and 23, Raaijmakers teaches processes for forming ultra thin dielectric stacks of high quality. First, a wafer is cleaned to provide a clean silicon surface (i.e. providing a silicon substrate) col. 13, lines 43-45. Then, the method

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includes loading the said substrate into a processing chamber at 780°C where a first oxide layer grows on the semiconductor structure (i.e. thermal oxide layer) col. 13, lines 57-59. A silicon nitride layer is then deposited over the thermal oxide layer forming a stacked gate dielectric (col. 3, lines 20-35). During an anneal step, the substrate is exposed to a nitriding agent (i.e. nitridation process) followed by exposure to an oxidizing agent (i.e. reoxidation process) col. 15, lines 21-37. A remote plasma generator is located upstream from the reaction chamber and is connected to each gas line via separate mass flow controller and valves, allowing for said plasma nitridation/reoxidation processes (col. 7, lines 44-65).

Regarding claims 2 and 24, Raaijmakers teaches a processes where the thermal oxide layer grows to about 0.5 nm (or 5 angstroms) while the silicon nitride layer grows to about 3 nm (or 30 angstroms) col. 14, lines 3-5, 19-21.

For claims 4-7 and 26-29, Raaijmakers teaches a processes for forming ultra thin dielectric stacks of high quality where the dielectric growth and deposition steps (i.e. formation of the thermal silicon oxide and nitride layers) are conducted in the rage of 650-850°C (col. 11, lines 7-23).

As per claims 8 -10 and 30-32, Raaijmakers teaches a process for forming ultra thin dielectric stacks of high quality where oxide layer is a thermal silicon oxynitride and the CVD nitride layer consists of silicon nitride (col. 11, lines 25-29; col. 14, lines 1-5,18-21).

Regarding claims 11 and 33, Raaijmakers teaches a method of forming a nitride layer by a remote plasma enhanced (RPECVD) process. (col. 18, lines 34-46).

For claims 12-15 and 34-37, Raaijmakers discloses a process for forming ultra thin dielectric stacks of high quality where the plasma nitridation process is conducted at a temperature range of 650-680°C in a reaction chamber set within a range of 1-80 torr (col. 20, lines 34-36; col. 19, lines 22-26)

As for claims 20,21,42, and 43, Raaijmakers teaches a process for forming ultra thin dielectric stacks of high quality aided by plasma energy with an optional anneal step using nitriding or oxidizing agents (i.e. reoxidation step). The oxidant may be N₂O, NO, or O₂ (col. 11, lines 38-52; col. 17, lines 66-67; col. 20, lines 64-67).

Claim Rejections - 35 USC § 103

5. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

6. Claims 3 and 25 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers et al. (US 6,348,420) in view of Bloom et al. (US 6,228,779).

For claims 3 and 25, Raaijmakers teaches processes for forming ultra thin dielectric stacks of high quality. A thermal oxide layer grows to about 0.5 nm (or 5 angstroms) while the silicon nitride layer is about 3 nm (or 30 angstroms) col. 14, lines 3-5, 19-21. Raaijmakers, however is silent regarding a nitride layer of 5-15 angstroms.

Bloom teaches a method of forming a dense and stable dielectric layer of silicon nitride and silicon dioxide for use in transistors of ULSI circuits where the nitride layer is

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placed above the silicon dioxide layer. The said silicon nitride layer may be in a range of 5-20 angstroms (col. 3, lines 15-16). It would be obvious to one skilled in the art at the time of the invention to modify Raaijmakers' method by incorporating Bloom's nitride layer thickness in order to find the optimum nitride layer thickness for preventing the migration of dopants such boron into the silicon dioxide dielectric layer.

7. Claims 16-19 and 38-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers et al. (US 6,348,420).

Regarding claims 16-19 and 38-41, Raaijmakers teaches a process for forming ultra thin dielectric stacks of high quality aided by plasma energy with an optional anneal step using nitriding or oxidizing agents (i.e. reoxidation step). The oxidant may be comprised of N_2O , NO , or O_2 (col. 11, lines 38-52; col. 17, lines 66-67; col. 20, lines 64-67). For deposition processes, the wafer is preferably kept at a temperature below about $750^\circ C$ in a chamber with a pressure range of 1-80 torr (col. 19, lines 22-26; col. 20, lines 19-21).

Although Raaijmakers states that the processing steps conducted in situ are conducted under similar or identical temperatures and pressures (col. 19, lines 18-22,) Raaijmakers is silent with regard to a specific temperature and pressure range during the reoxidation step. However, It would be obvious to one skilled in the art at the time of the invention to maintain the parameters of the reactor chamber at the temperature and pressure of the silicon oxynitride and nitride deposition during the annealing

(reoxidation) step in order to avoid pressure/temperature ramping and minimize thermal stress that could cause peeling of coatings from the substrate.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to FRANCIS P. SMITH whose telephone number is (571)270-3717. The examiner can normally be reached on Monday through Friday 7:30 AM-5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mikhail Kornakov can be reached on (571)272-1303. The fax phone

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number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

FPS

/Michael Kornakov/

Supervisory Patent Examiner, Art Unit 1792